Iowa Department of Natural Resources
Checklist for Bridge Project Applications

In order for this project to be reviewed in the shortest time possible, we ask that you make certain that the following items are included with your bridge application

- ☐ Completed and Signed Application
- ☐ IDOT Form 1E (if applicable)
  - ☐ 2-Sets of Design Plans (full size) Containing the Following:
  - ☐ Survey Datum Reference
  - ☐ North Arrow
  - ☐ Site Map
  - ☐ Pier Width
  - ☐ Elevation of Low Chord
  - ☐ Elevation of Low Point in Approach Grade
  - ☐ Existing Bridge Date (if applicable)
- ☐ Hydrologic Calculations (50 yr. & 100 yr. floods)
- ☐ Hydraulic Calculations, Including the Following (where applicable):
  - ☐ Plotted Valley Cross-Section (for Hydraulic Design Series 1 Review)
  - ☐ Map Showing Location of All Valley Cross-Sections Used
  - ☐ Summary of Hydraulic Calculations, Including Stream Slope, Velocity, Backwater and Freeboard for 50 yr. and 100 yr. flows.
  - ☐ Hard copy of all hydraulic models (for HECRAS, WSPRO, PCVAL, etc.)
  - ☐ Disk with copy of all hydraulic models (for HECRAS, WSPRO, PCVAL, etc.)
- ☐ Variance Request Letter (if applicable)

Date: ___________
Completed By: __________________

Bridge Analysis Guide

1. **Application**: Completed and Signed Joint Application Form Submitted? Yes_____ No_____

Applicant Name: _________________________________

Location: _______ Sec _______, T_______N, R________ , County: ____________________

Stream(s): ____

2. When Permit Required:

567—71.1 (455B) Bridges, culverts, temporary stream crossings, and road embankments. *Approval by the department for the construction, operation, and maintenance of bridges, culverts, temporary stream crossings, and road embankments shall be required in the following instances.*

71.1(1) *Rural area—floodway. In rural areas, bridges, culverts, road embankments, and temporary stream crossings in or on the floodway of any river or stream draining more than 100 square miles. (NOTE: Channel modifications associated with bridge, culvert or roadway projects may need approval; see 567—71.2(455B).)*

71.1(2) *Rural area—floodway and flood plain. Road embankments located in the floodway or flood plains, but not crossing the channel of a river or stream draining more than 10 square miles, where such works occupy more than 3 percent of the cross-sectional area of the channel at bankfull stage or where such works obstruct more than 15 percent of the total cross-sectional area of the flood plain at any stage. In determining a 15 percent occupancy of the flood plain, the concept of equal and opposite conveyance as defined in 567—Chapter 70 shall apply.*

71.1(3) *Urban areas. In urban areas, bridges, culverts, road embankments and temporary stream crossings in or on the floodway or flood plains of any river or stream draining more than 2 square miles.*

567—71.2 (455B) Channel changes. *Approval by the department for the construction, operation, and maintenance of channel changes shall be required in the following instances.*

71.2(1) *Rural areas. In rural areas:*

b. Channel changes associated with road projects in or on the floodway of any stream draining more than 10 square miles at the location of the channel change whereby either (i) more than a 500-foot length of the existing channel is being altered or (ii) the length of existing channel being altered is reduced by more than 25 percent.

71.2(2) *Urban areas. In urban areas channel changes on any river or stream draining more than 2 square miles at the location of the channel change.*

Located within a Corporate Limits? Yes ______ No ______

Drainage Area: _________________________ Approval Needed? Yes ______ No ______

Channel Change Involved? Yes ______ No ______

Channel Change >500 ft or reduces length by more than 25%? Yes ______ No ______

3. **Engineering Plans**: 2 Sets of Certified Plans Submitted? Yes ______ No ______

Location Map Included? Yes ______ No ______ *(Quad Maps Available at http://ortho.gis.iastate.edu/)*

Site Map Included? Yes ______ No ______

Survey Datum: ______________ (NGVD, other, explain)

Typical Stream Width: ______________ Typical Flood Plain Width: _____________

Channel Bottom Elevation: ___________ Average Flood Plain Elevation: __________

Record High Water Elevation: ______________ Date:______

Existing Bridge Length: _____________ Proposed Bridge Length: ______________

Bridge Skew (Degrees): Bridge to Stream: ______

Piers to Stream: ______

Abutments to Stream: ______

Low Steel (Chord) Elevation: At Right Abutment ___________

At Left Abutment ____________

At Mid Span __________

Abutment Berm Elevation: Left ___________ Right___________ Side Slopes: __________

Pier Width: __________ Pier Type (T-Pier, Pile Bent, other): ______________________________

Extent of Roadgrade Change (length, elevation, etc.): _____________________________________

____

Channel Excavation for Transition (expansion/contraction)? Yes ______ No ______

Explain: ____

4. Hydraulics & Hydrology:

Does Community Have a Detailed Flood Insurance Study (FIS)? Yes _____ No _____ *(If "Yes" continue with Section **4.a**. If " No", Skip to Section **4.b**, for the situation where No Detailed FIS Exists for The Stream)*

a. If "Yes", Does Study Include Detailed Information (Floodway and 100 yr. Flood) Information For this Stream? Yes _____ No _____ *(If "No", Skip to Section **4.b**, for the situation where No Detailed FIS Exists for The Stream).*

Was Original Hydraulic Model Obtained From FEMA Library (301-210-6800)? Yes ____ No ____

If "No", Explain: ____

If "No", What is Source of Information? ____________________________________

____

When analyzing the effects of a new or replacement bridge where a detailed Flood Insurance Study (FIS) exists, the following series of hydraulic models should normally be performed in the specified order to create a "Base" condition. Please Check that these runs were done in the order listed:

Step #1) Original Hydraulic Model As Received From FEMA. _____

Step #2) Original Hydraulic Model With Corrections Made. _____

Step #3) Corrected Model With Additional Cross-Sections Located At The Project Site. _____
(Modeling for a "new" bridge will require inserting cross-sections immediately upstream and downstream of the proposed bridge location. Models for replacement bridges will likely not require additional cross-sections as they should be in the original model obtained from FEMA.)

Step #4) Model from Step #3 with the new or replacement bridge included. _____

The model resulting from Step #3 will be the "Base" condition and will be used to determine the effects of the bridge on flood stages (e.g., backwater). *(Note: The hydraulic models specified above are the minimum needed to analyze the effects of the bridge on flood stages. Additional modeling may be required)*

Have all of the referenced hydraulic models been submitted on disk? Yes _____ No _____

*After completion of the Above Section, Skip to the "**Summary**" Section on Page 4*

b. **If No Detailed FIS Exists for This Stream**

Hydrology: 50 year Flood Discharge ___________ 100 Year Flood Discharge ____________

Source of Discharge Information (Check One):

___ USGS Regional Equations Report 87-4732
___ USGS Regional Equations Report 00-4233
___ Corps Study
___ WRC 17B analysis of Gage Data
___ Nearby Flood Insurance Study
___ Other (Explain) __________________________________

Stream Slope: _________ ft/ft

_________ ft/mi Source (topo map, *survey, other):_______________________

____

**(Note: If surveyed profile is used to determine stream slope, the length should be sufficient so as to be representative of the typical stream slope.)*

Method of Backwater Analysis(Check One):

___ HECRAS/HEC2 (Disk with Input/Output Included? Yes ___ No ___)
___ WSPRO (Disk with Input/Output Included? Yes ___ No ___)
___ PCVAL (Disk with Input/Output Included? Yes ___ No ___)
___ Federal Highway Administration Hydraulic Design Series 1 *(See Worksheet Page 7)*

Surveyed Valley Cross-Section Included *(Full Valley Section Required)*? Yes ___ No ___
Site Plan Showing Location of Cross-Section Included? Yes ___ No ___
Rating Curve Included? Yes ___ No ___
Backwater Calculations Included? Yes ___ No ___

Mannings "n" Value Used:

Channel _______ Left Overbank ______ Right Overbank _____

(Typical "n" Values are listed on Page 6)

Photographs Included to Verify "n" Values? Yes ___ No ___

Upstream Damage Potential: ____________________________________

Field Verified? Yes ___ No ___

5. Summary:

	50 yr. Flood	100 yr. Flood
Discharge (cfs)	______________	______________
Water Surface Elev.	______________	______________
Backwater	______________	______________
*Velocity	____________	____________
Freeboard	____________	____________
Waterway Opening (sq. ft.)	______________	______________
Road Grade Overflow (cfs)	______________	______________

*Are Velocities Excessive? Yes ___ No ___. If "Yes", What Stabilization Methods are Being Used? ____

6. Approval:

Approval Criteria:

567—72.1 (455B) Bridges and road embankments. *The following criteria shall apply to the construction, operation, and maintenance of bridges and road embankments.*

72.1(1) *Bridges and road embankments affecting low damage potential areas. For bridges and road embankments affecting floodway or flood plain areas having a low flood damage potential, the following criteria will apply:*

a. Backwater Q50. The maximum allowable backwater for Q50 and lesser floods is limited to 0.75 foot.

b. Backwater Q100. The maximum allowable backwater for Q100 is limited to 1.5 feet.

c. Freeboard. The minimum freeboard for low superstructure horizontal bridge members above Q50 is 3 feet.

Does Bridge Project Satisfy Criteria? Yes ___ No ___

Variance Requested? Yes ___ No ___

For (Check Appropriate Items): Freeboard ___ Backwater___

7. Variance:

Criteria For Variance:

567— 72.31 (455B) Variance.

72.31(1) *In general. Where evidence is presented that additional private or significant public damage will not result from flood plain or floodway construction (other than channel changes) subject to regulation under 567—Chapters 70 to 72, the department may permit variance to the criteria stated in Chapter 72.*

Possible Justifications For Variance:

- Grade Constraints
- Easements Obtained for Areas Affected By Backwater
- Low Potential for Debris and Ice Accumulation
- Bridge Designed to Withstand Inundation
- Substantial Roadgrade Overflow

If variance is requested, explain justification for request: ___________________________________

____

____

Note: A variance request should be made by letter and should include the above reference justification and explanation.

8. Out of Order Processing Requested:

Criteria for Out of Order Processing:

567—70.5(2) (455B) *Order of processing. In general, complete applications including sufficient plans and specifications shall be reviewed in the order that complete information is received. However, when there are a large number of pending applications, which preclude the department from promptly processing all applications, the department may expedite review of a particular application out of order if the completed application and supporting documents were submitted at the earliest practicable time and any of the following conditions exist:*

a. Relatively little staff review time (generally less than four hours) is required and delay will cause the applicant hardship;

b. The applicant can demonstrate that a delay in the permit will result in a substantial cost increase of a large project;

c. Prompt review of the permit would result in earlier completion of a project that conveys a significant public benefit;

d. The need for a permit is the result of an unforeseen emergency or catastrophic event; or

e. A permit is needed to complete a project that will abate or prevent an imminent threat to the public health and welfare

Request Made for Out of Order Processing? Yes ___ No ___

If "Yes", basis for request: ____

____

Typical Mannings "n" Coefficients for Natural Stream Valleys

<u>Channel</u>

Small to medium drainage areas	
Irregular section, meandering channel, rocky or rough bottom, medium to heavy growth on bank and side slopes.	0.04 – 0.05
Uniform section, relatively straight, Smooth earthen bottom, medium to Light growth on bank and side slopes.	0.03 – 0.04
Large drainage area	0.025 – 0.035

<u>Overbank Flood Plain Areas</u>

Pasture land	
No brush or trees	0.05 – 0.07
Light brush and trees	0.06 – 0.08
Crop Land	0.07 – 0.09
Brush and Trees	
Heavy weeds, scattered brush	0.08 – 0.10
Medium to dense brush and trees	0.09 – 0.12
Dense Brush and Trees	0.10 – 0.15
Heavy stand of timber, a few downed trees, little undergrowth	0.07 – 0.10

Federal Highway Administration
Hydraulic Design Series No. 1
Bridge Backwater Analysis

Flood Frequency Data

50 yr. , ______________ cfs	100 yr. , ______________ cfs
Stage , ______________ ft.	Stage , ______________ ft.
Velocity, ____________ fps	Velocity, ____________ fps
Alpha (α_1) , __________	Alpha(α_1) , __________

Skew

Bridge (relative to stream) _______ degrees

Piers (relative to stream) _______ degrees

	50 yr. Flood	100 yr. Flood
Bridge opening characteristics (sq. ft.) A_{n2} =	________________	________________
Skew Adjusted A_{n2} =	________________	________________
Roadgrade Overflow (if applicable) cfs.	________________	________________
a) $Q = CLH^{3/2}$ = C = 2.7 to 3.1 L = Length of weir H = Head	= $\underset{C)}{\_\_\_\_\_}\ \underset{(L)}{\_\_\_\_\_\_\_\_}\ \underset{(H)}{\_\_\_\_\_}^{3/2}$ = ______________	= $\underset{C)}{\_\_\_\_\_}\ \underset{(L)}{\_\_\_\_\_\_\_\_}\ \underset{(H)}{\_\_\_\_\_}^{3/2}$ = ______________
B Width (ft.) (See Page 9 Attached) $B = \frac{An2}{Y}$, Y = depth	= _____ = __________	= _____ = __________
Flow Distribution		
Q_a =	______________	______________
Q_b =	______________	______________
Q_c =	______________	______________
$M = \frac{Q_b}{Q_{Total}}$	= _____ = ________	= _____ = ________
K_b = (Figure 6, HDS1, Page 10 Attached)	________________	________________

$J = \frac{Area\_of\_Piers}{A_{n2}}$	= ______ = ________	= ______ = ________
$\Delta K_p = \Delta K\ (\sigma)$ (See Fig 7, HDS1, Page 11 Attached)		
$\sigma =$	________	________
$\Delta K =$	________	________
$\Delta K_p =$	________	________
Skew = ΔK_S (See Fig 10, HDS1, Page 14 Attached)	________	________
Eccentricity = ΔK_e (See Fig. 8, HDS1, Page 12 Attached)	________	________
$K^* = K_b + \Delta K_p + \Delta K_S + \Delta K_e$	________	________
Velocity (fps) $V_{n2} = \frac{Q_{Total}}{A_{n2}}$	________	________
Backwater (ft.) $h^* = (K^*)\ (\alpha_2)\ \frac{V_{n2}^2}{2g}$ $= (K^*)\ (1.5)\ \frac{V_{n2}^2}{2g}$	________	________

Freeboard

Low Superstructure Elevation ________

50 year Flood Elevation ________

Freeboard ________

The Following Figures Were Obtained From Federal Highway Administration Hydraulic Design Series No. 1 (HDS 1)

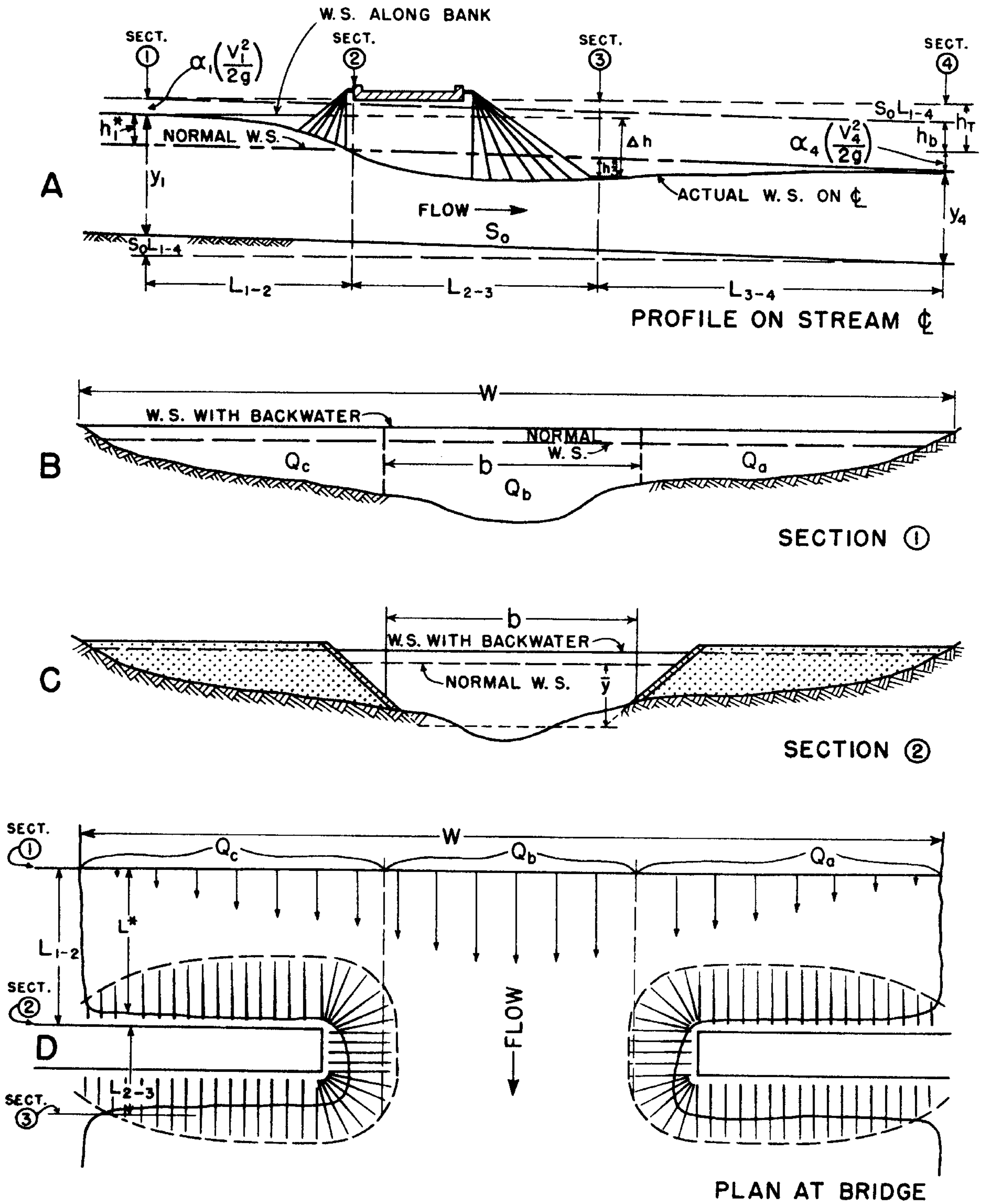


Figure 3.—Normal crossings: Spillthrough abutments.

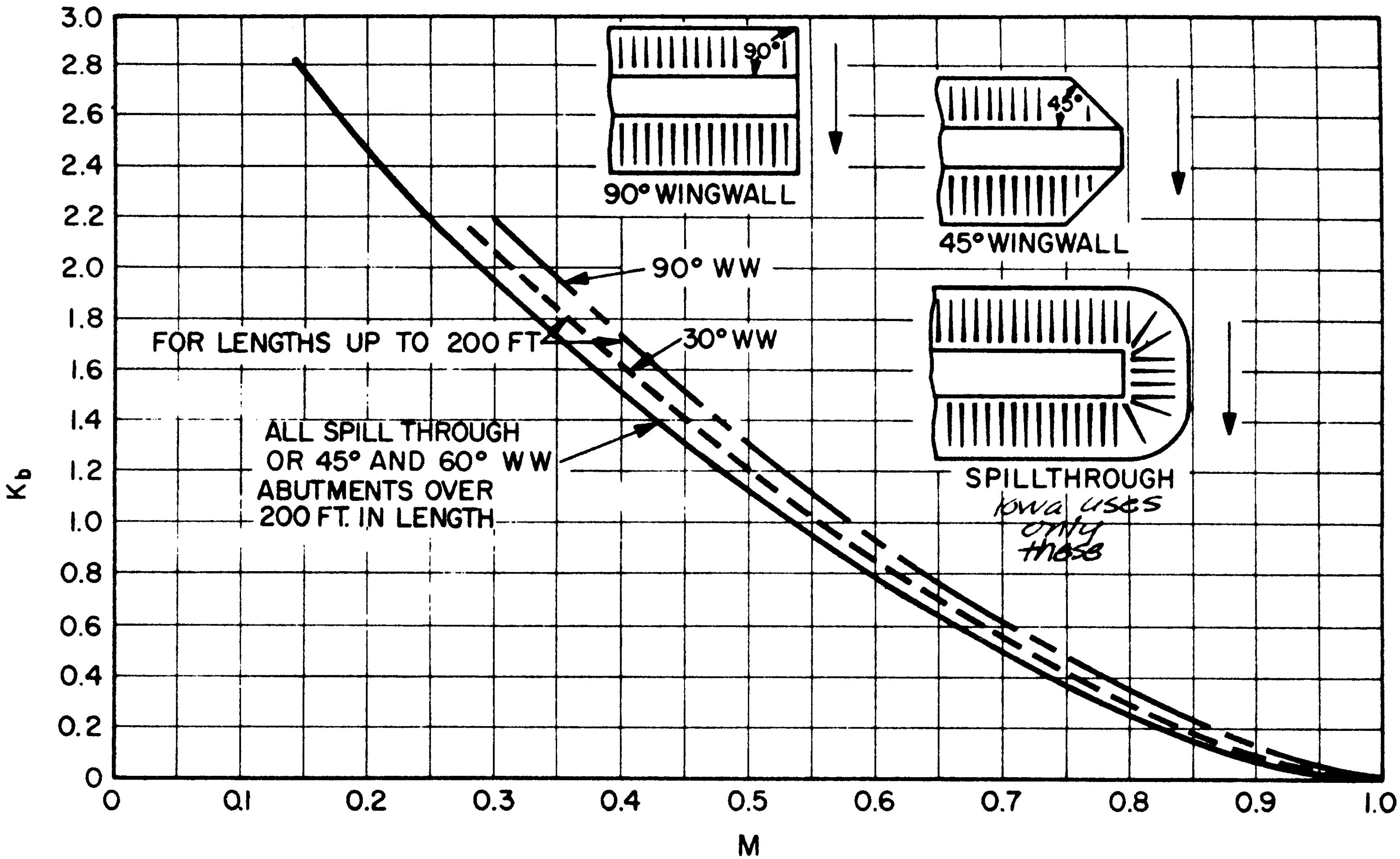


Figure 6.—Backwater coefficient base curves (subcritical flow).

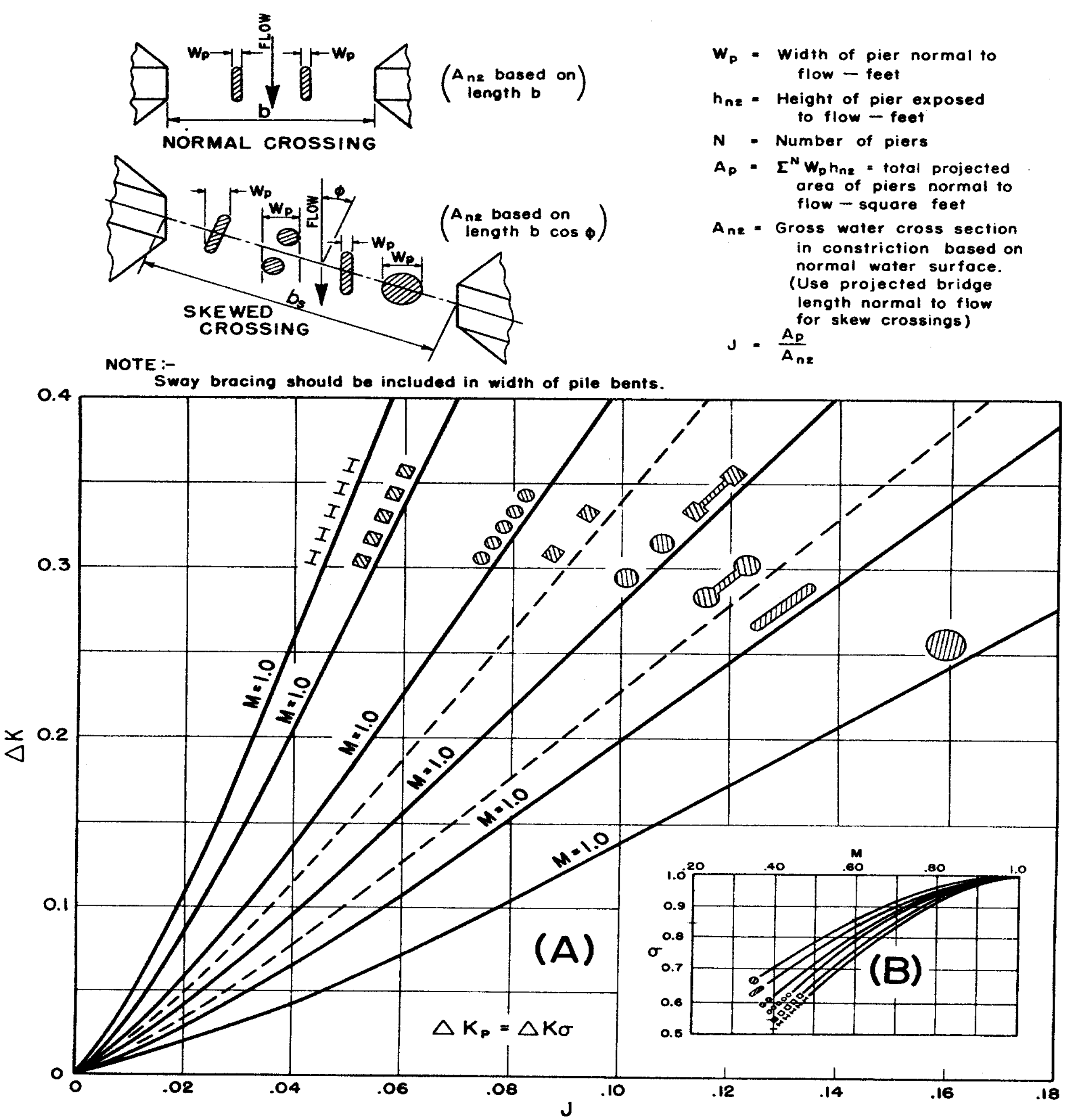
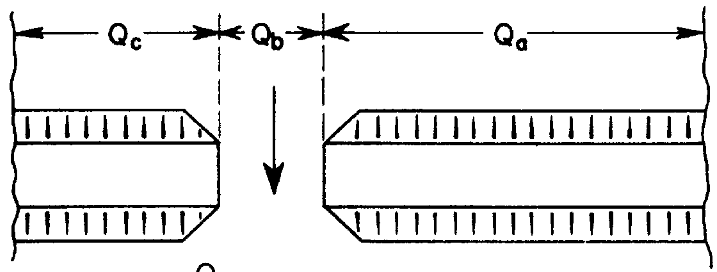


Figure 7.—Incremental backwater coefficient for piers.



$$e = \left(1 - \frac{Q_c}{Q_a}\right) \quad \text{where} \quad Q_c < Q_a \quad \text{or}$$

$$e = \left(1 - \frac{Q_a}{Q_c}\right) \quad \text{where} \quad Q_a < Q_c$$

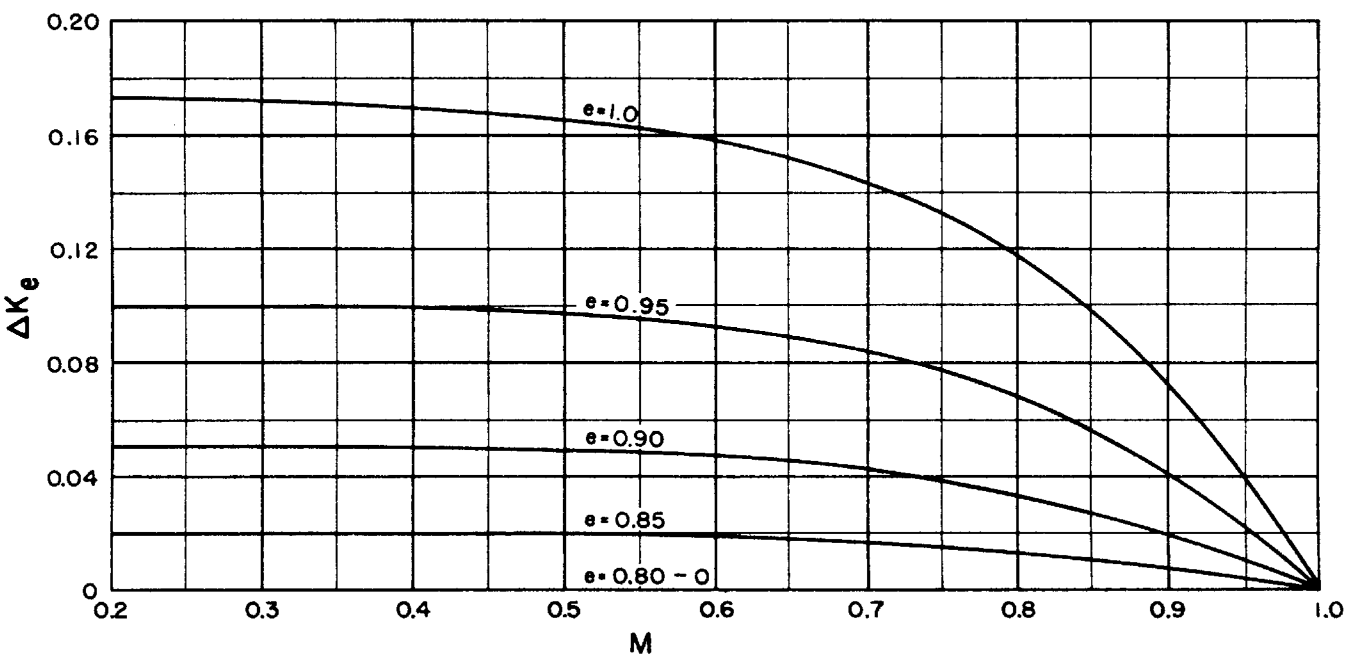


Figure 8.—Incremental backwater coefficient for eccentricity.

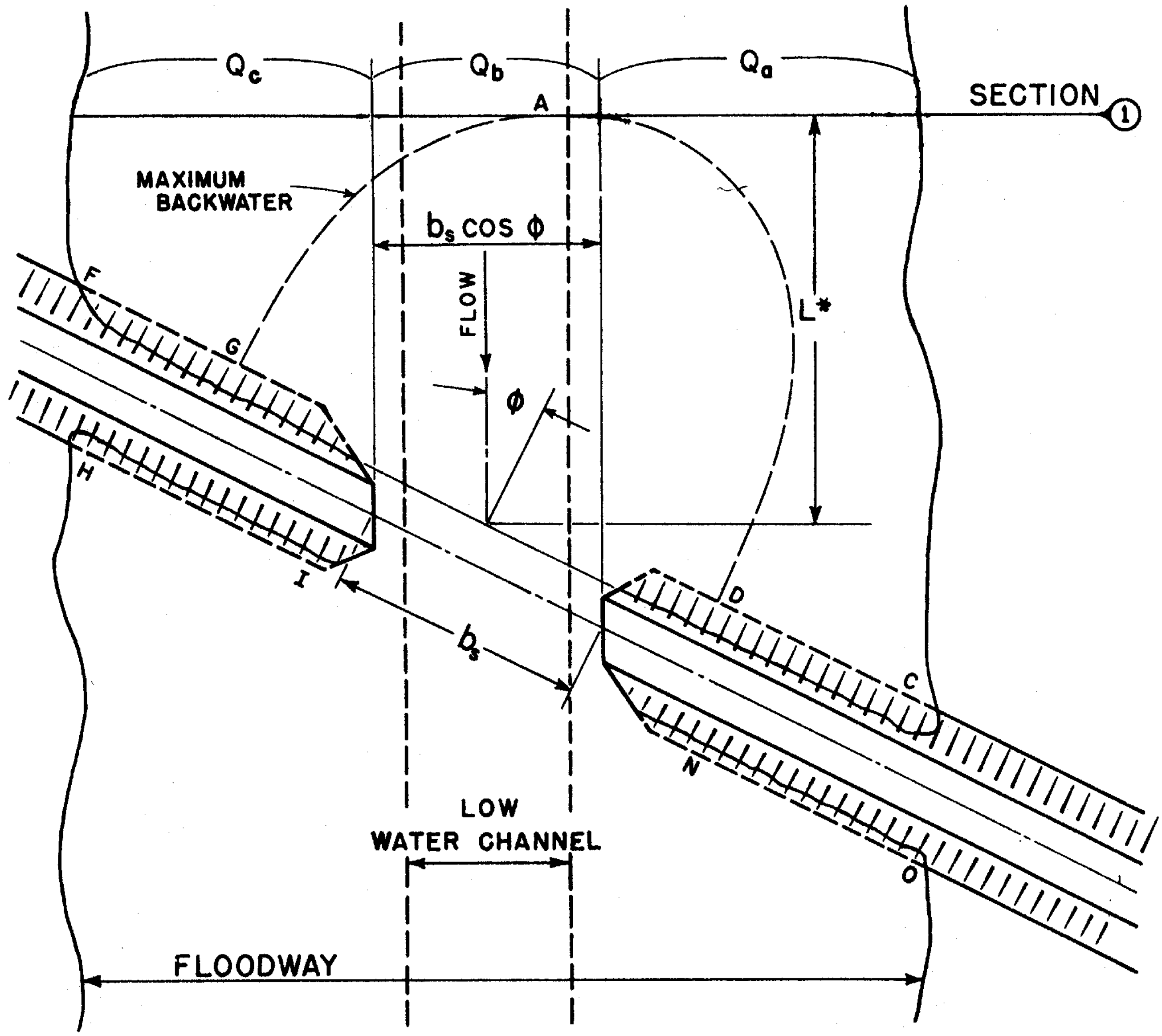


Figure 9.—Skewed crossings.

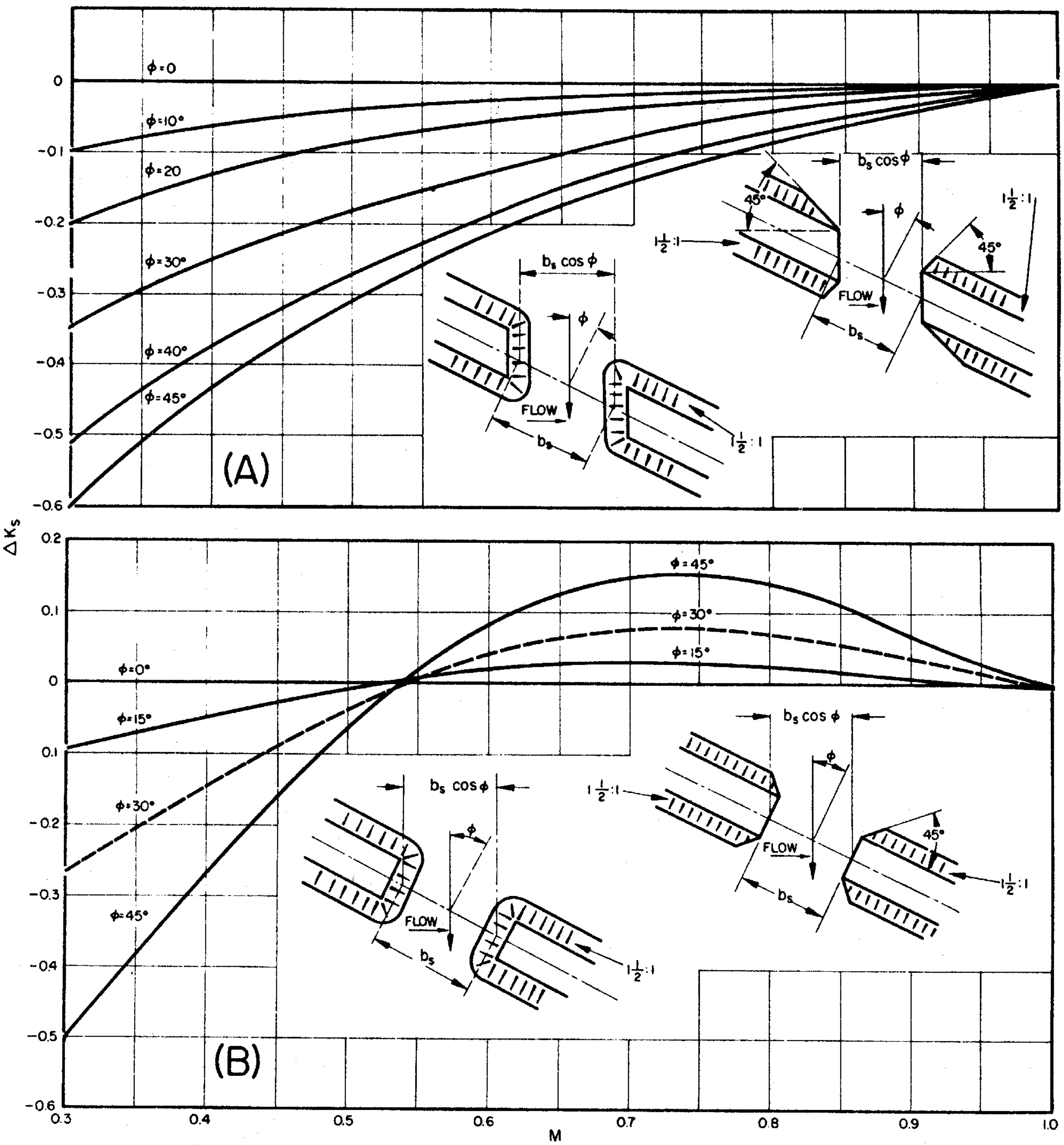


Figure 10.—Incremental backwater coefficient for skew.

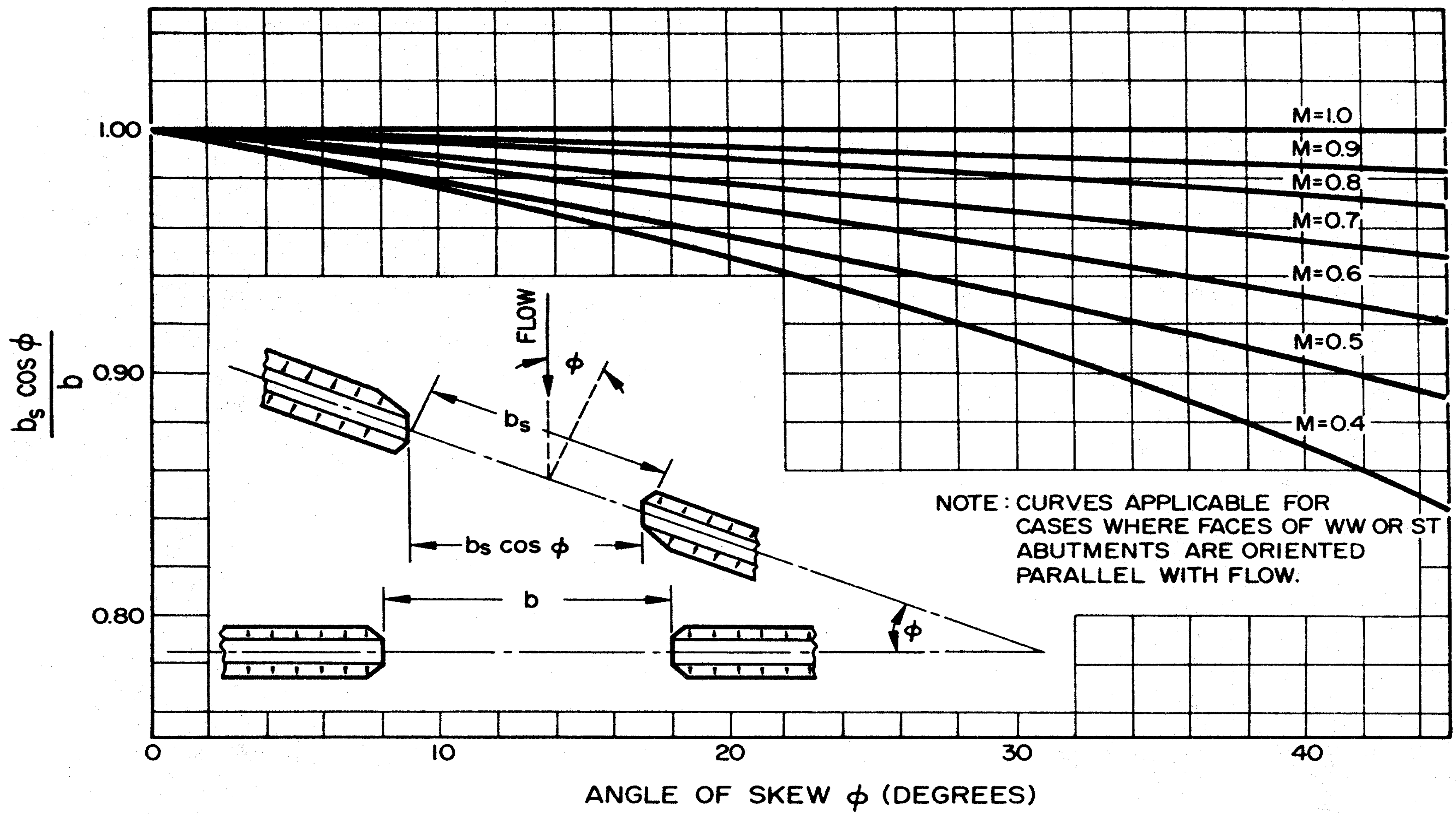


Figure 11.—Ratio of projected to normal length of bridge for equivalent backwater (skewed crossings).